# Measurement of R at KEDR

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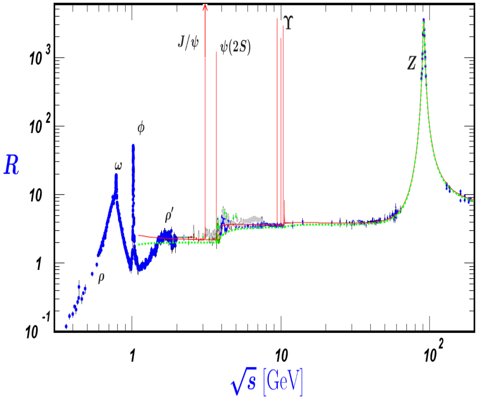
## Outline

- Motivation
- VEPP-4M collider and KEDR detector
- R measurement
- Summary

# Motivation

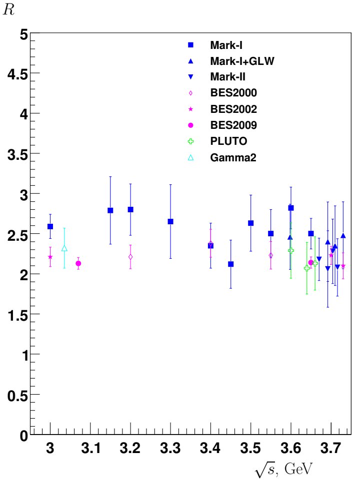



$$R(s) = \frac{\sigma_0(e^+e^- \to \gamma^* \to hadrons)}{\sigma_0(e^+e^- \to \gamma^* \to \mu^+\mu^-)}$$

***R* is necessary for dispersion integrals of hadronic vacuum polarization**

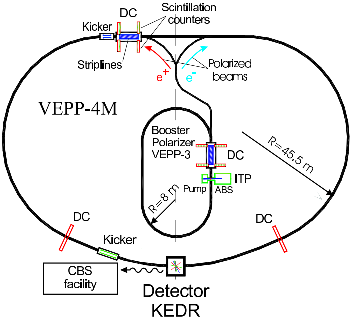
- $\alpha_{QED}(M_Z^2)$
- $(g-2)_\mu$

# Experimental motivation




- Systematic uncertainties dominate $\Longrightarrow$ More different experiments are needed

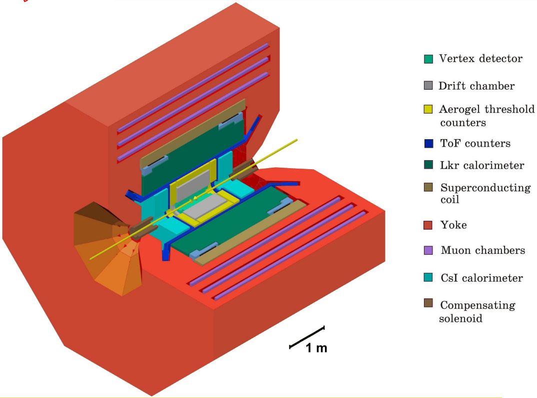
# VEPP-4M and KEDR



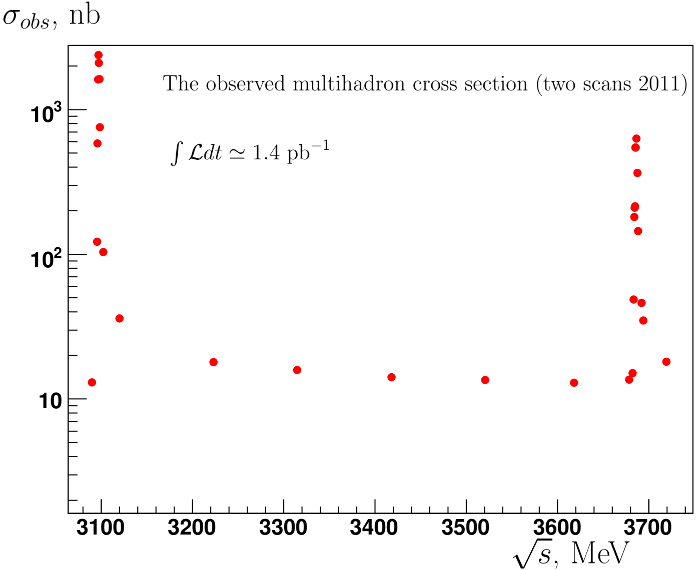

| | |
|---|---|
| Beam energy | $1 \div 5$ GeV |
| Number of bunches | $2 \times 2$ |
| Luminosity at 1.8 GeV | $1.5 \times 10^{30}$ cm$^{-2}$ s$^{-1}$ |

Energy determination uncertainty:

- Resonant depolarization technique $10 \div 30$ keV
- Infra-red light Compton backscattering $\sim 100$ keV



# The multihadron cross section in $J/\psi - \psi(2S)$ energy range



# Analysis

The way that we are measuring $R$:

$$R = \frac{\sigma_{obs}(s) - \sum \epsilon_{\psi}^{tail}(s)\sigma_{\psi}^{tail}(s) - \sum \epsilon_{bg}^{i}(s)\sigma_{bg}^{i}(s)}{\epsilon(s)(1+\delta(s))\sigma_{\mu\mu}^{0}} \qquad (1)$$

with $\sigma_{obs}(s) = \frac{N_{mh} - N_{res.bg.}}{\int \mathcal{L}dt}$ where $N_{mh}$ represent all events pass hadronic selection criteria, $N_{res.bg.}$ – residual machine background

$\sum \epsilon_{\psi}^{tail}(s)\sigma_{\psi}^{tail}(s)$ – is contribution from $J/\psi$ and $\psi(2S)$ resonances

$\sum \epsilon_{bg}^{i}(s)\sigma_{bg}^{i}(s)$ – is contribution from physical processes: $e^+e^- \to l^+l^-$, $\gamma\gamma$-processes.

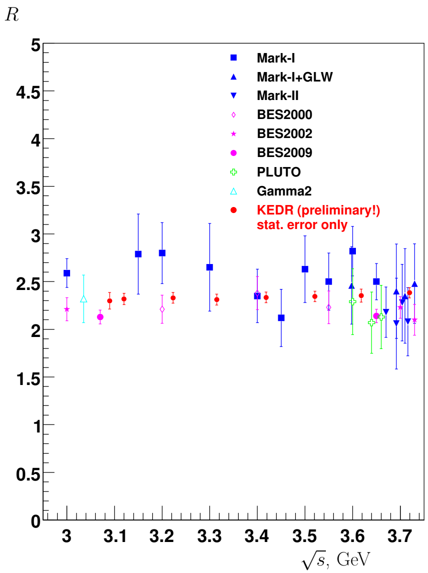
$\epsilon(s)$ – multihadron efficiency (The code of m.h. generator was kindly provided by the BES collaboration).

$$1+\delta(s) = \int dx \frac{\mathcal{F}(s,x)}{\left|1-\Pi_0(s(1-x))\right|^2} \frac{R(s(1-x))\epsilon(s(1-x))}{R(s)\epsilon(s)} \qquad (2)$$

$\mathcal{F}(s,x)$ – radiative correction (E.A.Kuraev, V.S.Fadin Sov.J.Nucl.Phys.41(466-472)1985)

Here $\Pi_0$ does not includes $J/\psi$ and $\psi(2S)$ resonances.

# Results


R
5
4.5
4
3.5
3
2.5
2
1.5
1
0.5
0
3
3.1
3.2
3.3
3.4
3.5
3.6
3.7
$\sqrt{s}$, GeV
Mark-I
Mark-I+GLW
Mark-II
BES2000
BES2002
BES2009
PLUTO
Gamma2
KEDR (preliminary!)
stat. error only

# The main systematic uncertainties in R value

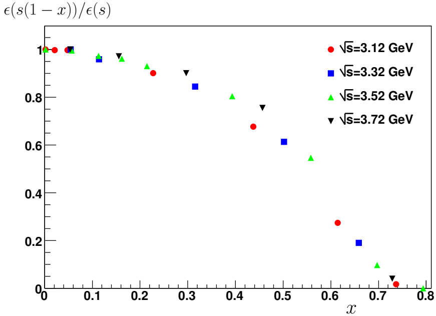
| Source | Error,% |
|---|---|
| Luminosity measurement | 1.0-2.0 |
| Simulation | 3.0-3.5 |
| Radiative correction calculation | 1.0 |
| Detector response | 1.0 |
| Accelerator residual background | 1.0 |
| *Sum in quadrature* | 3.6-4.4 |

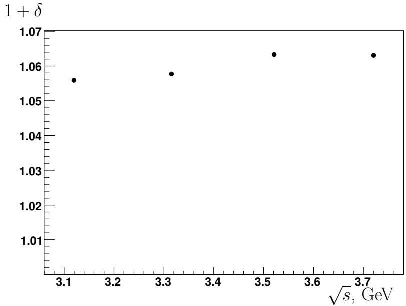
# Summary

- For R measurement KEDR take 1.4 $pb^{-1}$ at seven energy points in range 3.12-3.72 GeV
- Preliminary R values are obtained.
- We also have data below $J/\psi$ (0.6 $pb^{-1}$), analysis in progress.
- KEDR R plans:
  - Repeat R scan in the energy range 3.12-3.72 GeV
  - Experiment with VEPP-4M at $E_{beam} > 2.5$ GeV

# BACKUP SLIDES

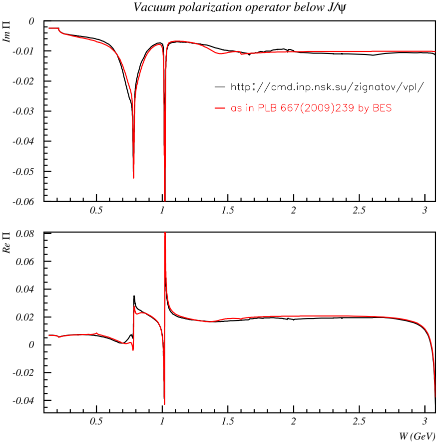
# Radiative correction




Differential efficiencies have been used to calculate radiative correction at the each energy point.

# $\Pi_0$ calculation




To reduce the systematic uncertainty in the calculation of the the vacuum polarization operator we use the cut on the sum of the particles energies (more than 1.6 GeV).

# Multihadron efficiency (MC simulation)